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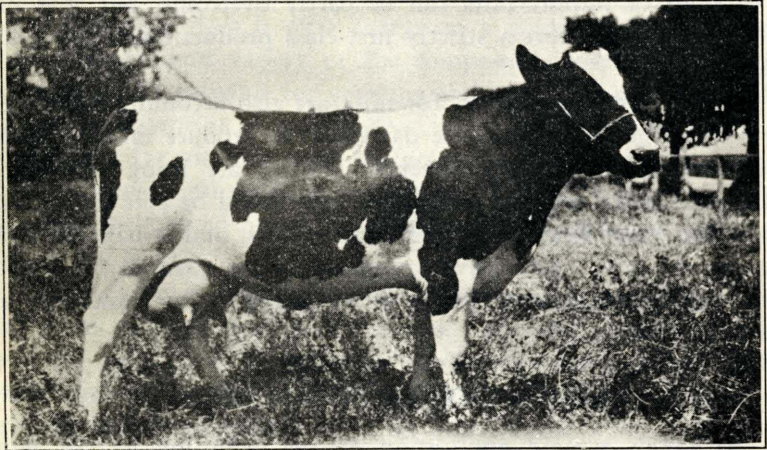


CIRCULAR 69

FEBRUARY, 1928.

Clean Milk and Its Production

E. G. CARTER



UTAH AGRICULTURAL EXPERIMENT STATION

LOGAN, UTAH

CLEAN MILK AND ITS PRODUCTION

E. G. CARTER

Successful dairy farming is fast growing into an exacting profession, and in order to be successful the dairy farmer must not only recognize the value of good clean milk but must know how to produce it as well. Good milk, good butter, and good cheese are acknowledged to be in great demand, and each brings fair financial returns.

Since the beginning of the dairy industry one of the big difficulties has been that of obtaining clean milk and cream. By applying the best scientific methods in the manufacture of dairy products the ill effect of impure milk can be partly overcome, but it is impossible to manufacture a strictly first-class product from low-grade milk.

The health requirements for milk are also becoming more rigid every year, and it is up to the dairymen to produce milk of better quality to meet these requirements. People are being encouraged to use more dairy products; therefore, we should be able to say that milk comes from clean herds and clean stables, and is handled right all along the line. Expensive equipment is not essential for a good dairy, but common sense and a strict ruling as to cleanliness are necessary.

DEFINITION OF CLEAN MILK

Although a rigid application of the definition of the word "clean" would exclude milk that contains foreign matter or any bacteria whatever, for ordinary purposes "clean milk" may be understood to be milk of good flavor from healthy cows, that is, free from dirt and containing only a small number of bacteria, none of which are harmful.

At the Paris Exposition in 1900, as pointed out by Spargo, 'one of the most significant of all the food exhibits was that of the American dairy products, particularly of milk and cream. European authorities were astounded. They could not understand how it was possible for milk and cream (raw, in its natural state, without preservatives of any kind) to be shipped from New York, New

Jersey, or Illinois to France and be in good condition upon its arrival and still remain pure and sweet. The French agriculturists were dumbfounded, for they could not bring their milk a distance of little more than one hundred miles and have it in good condition for more than 48 hours under the most favorable conditions. Major Alvord, who was in charge of the exhibit, found it no easy matter to convince the milk experts on the jury that the milk was in its natural state, uncooked, and undoctored, and that nothing but 'cold and cleanliness were used to attain such wonderful results.' "

FOOD VALUE

Milk is unquestionably one of the most important of all human foods. Not only does it offer energy in a readily available form, but the amount and variety of the compounds contained in milk make it especially valuable for growing children. The present daily per capita consumption of milk in the United States is about one-half pint, which is far too low when the great food value of milk is considered. Doctor Graham Lusk, formerly of Cornell University, who represented the United States on the Interallied Council of Alimentation in 1918, says:

"No family of five should spend any money for meat until three quarts of milk have been purchased and this should be done even if the price of milk should go to twenty cents a quart. Absolutely nothing in the food line will keep children so healthy as their daily supply of milk."

Both whole milk and skim milk are among the best and cheapest of foods. Nevertheless, they are used in greater quantities by the rich than by the poorer classes. A survey of the different districts in New York revealed the fact that the poor not only use less milk than the well-to-do but the use of store milk and of canned milk was largely confined to the laboring classes, or, in other words, the people who most needed to be careful in their buying used small quantities of the cheapest food which they bought in the most expensive form.

The following tabular material compiled by specialists of the United States Department of Agriculture, shows the quantities of various foods needed to supply as much protein or energy as one quart of milk:

PROTEIN	ENERGY
1 quart of milk is equal to:	1 quart of milk is equal to:
7.0 ounces of sirloin steak	11.3 ounces of sirloin steak
6.0 ounces of round steak	14.9 ounces of round steak
4.3 eggs	9.0 eggs
8.6 ounces of fowl	14.5 ounces of fowl

Another method of comparison is shown by the table below, in which the relative value of certain foods as economical sources of protein is given:

MILK AT	IS AS CHEAP AS SIRLOIN STEAK AT	OR EGGS AT
7 cents a quart	16.3 cents a pound	17.6 cents a dozen
8 cents a quart	18.6 cents a pound	20.1 cents a dozen
9 cents a quart	21.0 cents a pound	22.6 cents a dozen
10 cents a quart	23.2 cents a pound	25.1 cents a dozen
12 cents a quart	27.9 cents a pound	30.2 cents a dozen
15 cents a quart	34.9 cents a pound	37.7 cents a dozen

This, however, considers milk only from the protein and energy content. But milk also has other functions, furnishing essential food accessories to the growing animal which are not furnished by all foods and which cannot be measured in heat units. This is confirmed by the experiments of Dr. E. V. McCollum of Johns Hopkins University, who has published the results of many years of experiments with young animals fed upon vegetable fats and others fed upon animal fats.

The results plainly indicate that there is something in milk and butter that is essential to the development of young animals and to the maintenance of the health of mature animals. This essential factor is called a vitamin and is found to be lacking in practically all milk and butter substitutes.

Vitamins of three kinds are present in milk: One is fat-soluble and is found abundantly in the butter fat. A second one is water-soluble and is present in milk from which the fat, to a large extent, has been entirely removed. In these two vitamins, which are not injured by heat, milk is comparatively rich. Milk also contains a third vitamin, known as the antiscorbutic vitamin, which prevents scurvy. The amount of this vitamin in milk varies considerably. It is probably affected by the feed of the cow and by heating the milk.

DANGERS FROM IMPURE MILK

Milk, like all other good things, has its drawbacks; this is because it is subject to contamination and at times may convey the germs of disease. Milk stands second only to water as a vehicle of disease transmission. A public water-supply unquestionably reaches a larger percentage of people than any other single potential disease vehicle, but milk follows a close second. It is easy to understand, therefore, why milk supplies, unless properly controlled, should be the vehicle for frequent outbreaks of disease, especially if it is remembered that milk is a natural growing medium for certain disease-producing bacteria.

The frequency of milk-borne outbreaks of disease is well known. Surgeon Trask* lists the following milk-borne outbreaks as occurring during the 27-year period, 1880-1907:

DISEASE	NO. OF OUTBREAKS
Typhoid fever	317
Scarlet fever	125
Diphtheria	51
Septic sore throat	7
<hr/>	
Total	500

These figures, of course, are incomplete, and it must be obvious that many more outbreaks occurred than were reported in the literature. It must be remembered also that milk-borne epidemics are still occurring with great frequency in the United States. Furthermore, milk is responsible for a large amount of "bovine" tuberculosis among children, a damage which is more insidious and less easily traced than that caused by the more spectacular outbreaks of epidemic diseases.

Milk-borne outbreaks of disease usually present certain distinguishing characteristics which serve to determine their source. Generally, the disease is confined to the milk route of a certain dealer, that is, to families using a particular supply. Only those who actually use the infected milk or its products are attacked. People in the better walk of life are, if anything, more subject to the disease than those in poorer circumstances; women and children are also

* Hygienic Laboratory Bul. 56 (1909)

more frequently made ill than others, because they are more likely to be milk consumers.

In order to banish the suspicion of danger from disease germs, which is now a factor limiting the consumption of milk, the milk must be either produced under careful supervision regarding the health of the cows and men or it must be properly pasteurized.

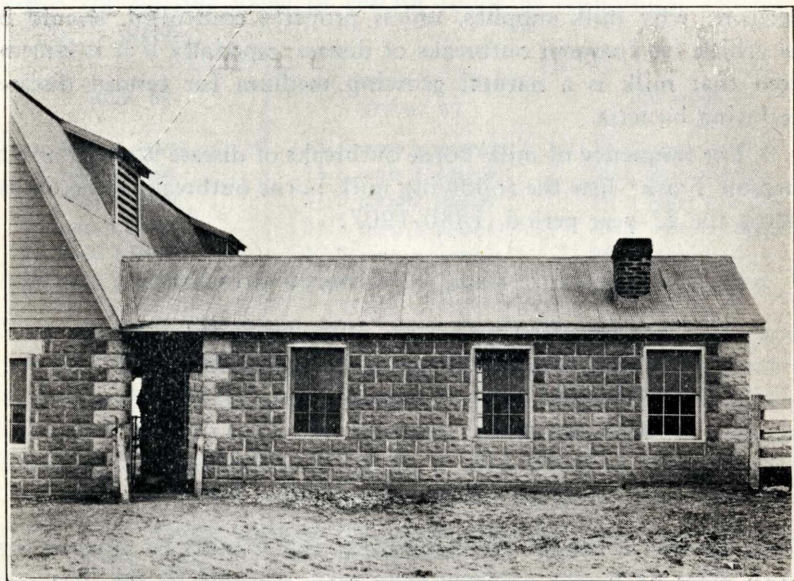


Fig. 1. An economical dairy house connected with the barn by a well-ventilated passageway. (Courtesy, Bureau of Dairying, U. S. D. A.)

CLEANLINE SS OF MILK

Milk is invariably produced in surroundings which favor the introduction of dirt. It has been truly said that if milk were a transparent rather than an opaque fluid the dirt contamination would be much more evident. It is not to be expected then that milk, which is one of the most perishable of all foods and one of the most susceptible to the influence of dirt and bacteria, can be obtained in a pure condition without regard to strict rules of cleanliness.

The sediment most commonly found in milk is manure, mixed with dust from the air, bits of straw, hair, and particles of all kinds.

Dirt is present because the milk does not get the care and attention it should have on most farms. This contamination is not always visible to the eye, as a certain amount of the material is almost immediately dissolved, but whether in solution or suspension it is undesirable. Frequently, however, dirt is present in sufficient quantity to impart a characteristic taste to the milk and can be found as a sediment in the bottom of the container. The absence of dirt, although a good indication, by no means signifies that a milk is safe for consumption. The dirt may have been removed by straining or clarifying, leaving behind the injurious bacteria which it may contain.

A simple test for the presence of visible dirt can be performed with absorbent cotton. In applying this test, measured quantities of milk are passed through cotton, and the dirt is observed as a residue upon the white cotton. The discoloration is in proportion to the amount of undissolved dirt present. Clean milk will show only the slightest brown discoloration. Cleanliness is not an absolute safeguard against disease, but it is an important factor in preventing contamination.

BACTERIA IN MILK

Bacteria play a very important role in the milk and dairy industry. Practically all the changes that take place in milk, from the time it is drawn until consumed, are due to the action of microorganisms. It is a familiar observation that milk sours on standing. The agency of bacteria in this, one of the earliest known fermentations, was established by the work of Pasteur in 1857.

Many of the bacteria commonly found in milk produce no apparent change, while others cause great changes both in the appearance and the flavor of the milk. The lactic acid-producing organisms, for example, can almost be regarded as normal constituents of milk as they are practically always present, even in supplies considered perfectly pure. They bring about fermentation of the milk sugar, changing it into lactic acid, which when present in sufficient quantity precipitates the casein and produces what is known as sour milk.

The normal acid-producing bacteria are useful in the manufacture of butter and cheese because they develop a desirable taste and aroma in these important dairy products. The lactic acid bacteria

are also valuable in another way, in that they serve to check the multiplication of injurious organisms. Other forms of bacteria are concerned in the putrefaction of milk, a change which fortunately usually occurs only subsequent to souring.

NUMBER OF BACTERIA IN MILK

The number of bacteria found in milk is an index of its sanitary production, its age, or the temperature at which the product has been maintained. The bacterial content of fresh milk is always in proportion to its cleanliness, and cleanliness is to a great extent a measure of the safety. In market milk, however, the temperature at which the product has been maintained, the amount of handling it has undergone, and its age are also factors in determining the number of bacteria present.

According to experiments of the U. S. Department of Agriculture, the number of bacteria in samples of milk held at 50° F. for 24 hours increased fourfold; but when the milk was held at 68° F. the original number multiplied over 6000 times. In other words,

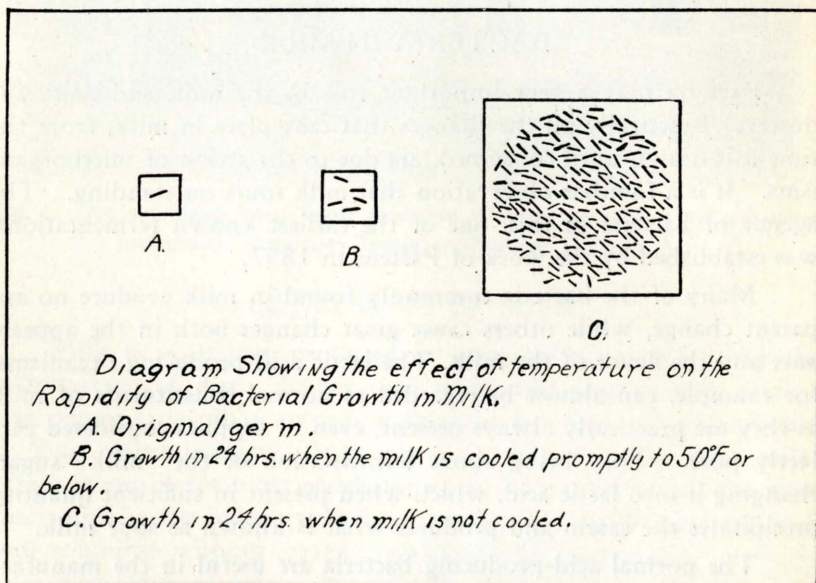


Fig. 2. Diagram showing the effect of temperature on the rapidity of bacterial growth in milk.

if at the beginning, the milk had contained 1000 bacteria per cubic centimeter, after being held at 50° F. for 24 hours, the bacteria would have increased to 4000 per cubic centimeter. Held the same length of time at a temperature of 68° F., the bacteria would have increased to more than 6,000,000 per cubic centimeter. Figure 2 shows graphically the effect upon germ growth of holding milk at 50° and 68° F., respectively.

The limit to be placed upon the number of bacteria in milk is somewhat difficult to fix. A low count for a city would be a high count for a country milk. The climate, season of the year, transportation facilities, and availability of ice are all matters to be considered in fixing a standard. In small communities where the milk is produced within a few miles of the point of delivery bacterial counts of 100,000 may be considered excessive. In larger cities receiving their supplies from places a hundred miles or more distant counts below 100,000 are rare, unless the milk has been pasteurized.

PASTEURIZATION

Pasteurization means heating the milk to a temperature of not lower than 145° F. for not less than 30 minutes. Following this, it is promptly cooled to 50° F., or below. Pasteurization under this method does not render the milk sterile but makes it safe in so far as the transmission of diseases is concerned. A number of types of harmless but desirable bacteria which cause milk to sour are not killed by this heating process, so that pasteurized milk sours in the same manner as raw milk, although the time it remains sweet is prolonged about 24 hours.

Pasteurization, properly performed, is universally recognized by health authorities as the most economical and effective method of rendering milk safe. It is now agreed that all market milk should be pasteurized. This treatment is not intended as a substitute for lax or unclean methods of production, but its purpose is primarily to overcome certain dangers in raw milk which even careful dairy inspection may not eliminate.

HOW TO PRODUCE CLEAN MILK

In the production of clean milk expensive barns and fancy

apparatus are not at all necessary. Most dairymen can do good work with simple and cheap equipment. The factors which are considered essential for clean milk production are as follows: (1) Clean, healthy cows; (2) clean milkers, free from disease; (3) small-top pails; (4) clean and sterilized utensils; (5) prompt and thorough cooling; (6) storage at low temperatures; (7) prompt delivery; and (8) freedom from abnormal flavors and odors.

Clean, Healthy Cows.—A healthy cow is the first requisite for

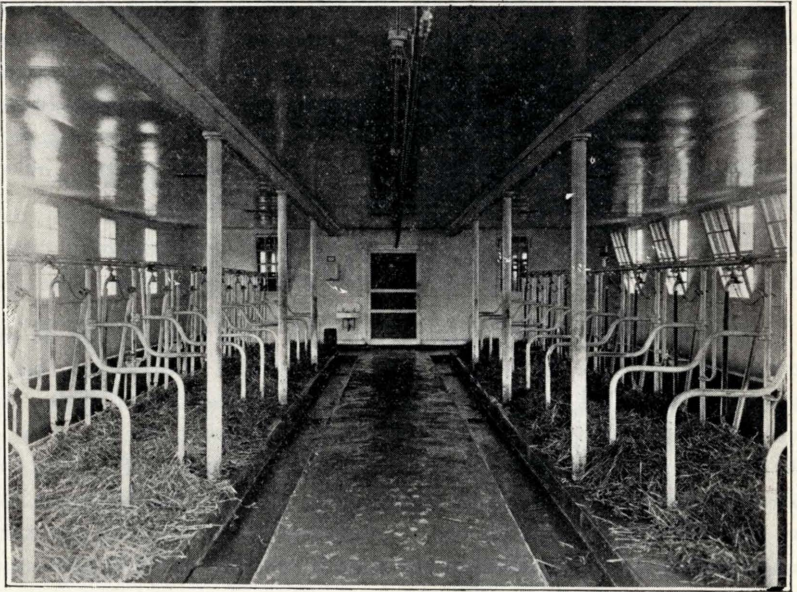


Fig. 3. Interior of a modern dairy barn. (Courtesy, Bureau of Dairying, U.S.D.A.)

clean safe milk and profitable dairying. Milk from diseased cows is likely to contain disease-producing bacteria. Tuberculosis is probably the most dangerous and widespread disease of cattle that can endanger the safety of milk. Cows should be tested for tuberculosis at least once a year by a capable veterinarian. All cows which react should be removed from the herd and the stable and premises thoroughly disinfected. Milk derived from animals afflicted with tuberculosis, anthrax, lumpy jaw, contagious abortion, or other infections should not be used.

In addition to a healthy cow, cleanliness of the cow is likewise important. The long hairs of the udder and flanks should be clipped to reduce the accumulation of dirt and manure. The use of a brush and curry comb each day is often necessary to keep the cows in proper condition. The udders and flanks should be carefully wiped with a clean, damp cloth just before milking, regardless of how clean they may appear.

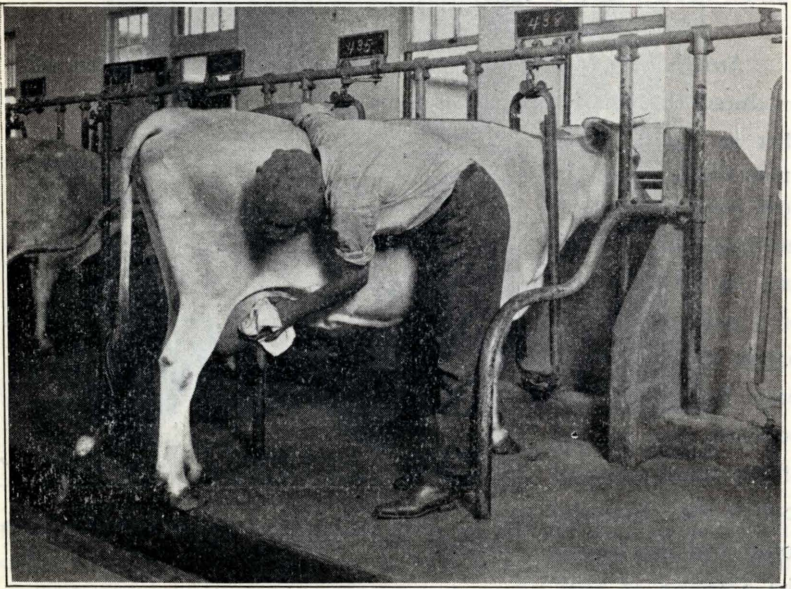


Fig. 4. Wiping teats, udder, and flanks of a cow with a clean, damp cloth.
(Courtesy, Bureau of Dairying, U. S. D. A.)

Clean, Healthy Milkers.—Clean hands, clean clothes, and clean habits are as essential to the production of good milk as they are to the housekeeper who prepares the meals. Milkers should wash their hands carefully before beginning work. It is well to remember that there is invisible dirt on the hands which is likely to contaminate or infect the milk. For this reason it is to the interest of the dairy that the hands should be kept away from the milk as much as possible. The practice of milking with wet hands is to be condemned as one sure to contaminate the milk. This is shown in the difference in the

germ content of milk drawn by two men milking in the same barn under identical conditions.

No. of Milkings		No. of Bacteria per cc.
Milker No. 1 (dry hands)	19	2,450
Milker No. 2 (wet hands)	19	17,100

The milker should always remember that he is handling a human food which is easily contaminated.

Small-Top Milk Pails.—In modern dairies where clean milk is produced the small-top pail is a necessity. Since most of the dirt in milk falls from the body of the cow into the pail at milking time, it is easy to see the value of a pail which is partly covered. It has been found, by experience, that the use of the small-top pail lowers the bacterial count and also lessens the amount of sedi-

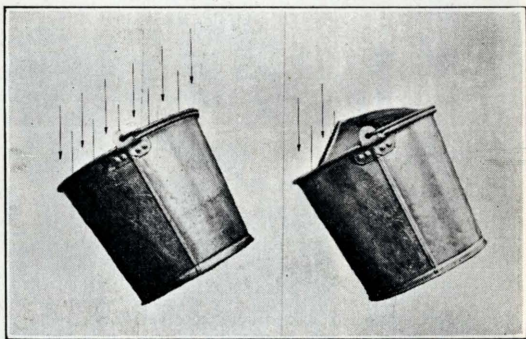


Fig. 5. Why the small-top pail is preferable to the ordinary pail. (Courtesy, Bureau of Dairying, U.S.D.A.)

ment in milk from the average dairy. The hooded milking pail, with an aperture not over five inches in diameter, is therefore to be considered a most important apparatus in the production of clean milk.

Clean and Sterilized Utensils.—The cleanliness and proper care of dairy utensils should be considered the most important item in producing milk with a low bacterial count. Not only is this important because it is the chief factor in the contamination of milk, but because much improvement can be secured with but little trouble.



Fig. 6. Milk utensils in a sterilizing cabinet ready to be steamed.
(Courtesy, Bureau of Dairying, U.S.D.A.)

Pails and cans may be apparently clean to the eye and yet contribute greatly to the germ content of the milk placed in them. Dairy utensils should be simple in construction, so that they can be readily and easily cleaned; otherwise, the cleaning process is likely to be neglected.

The following methods for the cleaning and care of utensils have proved most successful:

1. Rinsing in cold water immediately after using.
2. Washing thoroughly with a good stiff brush in warm water to which a cleansing powder has been added.
3. Rinsing thoroughly in clean, hot water.
4. Sterilizing with boiling water or steam for at least two minutes.
5. Removing the utensils while hot from the steam or water so that they will dry quickly from their own heat. Until used the

utensils should be kept inverted in a clean place, free from dust and flies. The importance of thorough heating and absolute drying cannot be over-emphasized.

Prompt and Thorough Cooling.—The temperature at which milk is kept is one of the important factors determining bacterial growth. Those familiar with milk know that it spoils very quickly if left standing at warm temperatures. When milk is cooled to 50° F., or lower, the keeping quality is greatly increased and the germ content reduced.

The equipment necessary for cooling milk at the dairy farm is exceedingly simple. Either a wooden tub or small concrete tank supplied with running water at a temperature not above 45° F., or filled with ice water, is all that is necessary. The cooling will be hastened if the milk is frequently stirred with a clean stirrer. Rapid, mechanical coolers are not required; in fact, if not properly used, they increase the chances for contamination. Every dairyman, however, should have a good thermometer so that cooling is not a matter of conjecture. Milk should always be cooled to 50° F., or below, and kept at that temperature until delivered.

Delivery.— While the milk is being delivered to the milk plant or consumer, if possible, it should be kept as cold as when in the cooling tank.

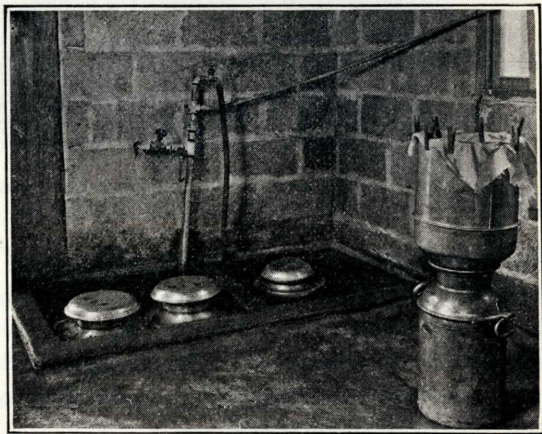


Fig. 7. Keeping cans of milk cold in a cooling and storage tank with ice water or cold running water. (Courtesy, Bureau of Dairying, U.S.D.A.)

Bottled milk can be kept cold during delivery by the use of cracked ice placed in the crates. Cans of milk may be protected from the heat of the sun by jackets or by canvas. Milk should be delivered as promptly as possible, since it is a very perishable product and must be handled accordingly.

Abnormal Flavors and Odors.—Milk is readily tainted because it absorbs odors and flavors. These abnormal flavors and odors find their way into the milk through the feed that the cows eat or by the exposure of the milk to the odors. Turnips, onions, milkweeds, and other strong-tasting substances fed to the cow will give flavor to the milk. In the early spring there is probably no plant which more seriously affects the flavor and odor of the milk than garlic or wild onion. Once the garlic flavor or odor has entered the milk, no efficient method of eliminating it is known.

Cattle, which have been fed fermented foods immediately before milking, or ensilage which is too green, or moldy grain and hay, may at times secrete milk of a distinctive odor. The characteristic "cowy" taste which is so common is due both to the absorption of odors from the stable and also to the presence of stable dirt and manure. When these flavors or odors are pronounced, it indicates carelessness and lack of cleanliness at the dairy.

Bitter milk may be caused either by certain plants eaten by the cow or by the action of bacteria. In the first case it is bitter when drawn, while in the second bitterness does not develop until several hours later. The same is true with colored milk. Plants which contain a large amount of pigment, if eaten, may produce abnormal coloration of the milk. Various bacteria also may produce discoloration. By far the most frequent cause of discoloration, however, is the presence of blood resulting from inflammatory disease of the udder. The use of milk of this character is dangerous; therefore, any variation from the normal color should be recognized as a warning signal.

SUMMARY

Clean milk is our best all-around food.

Milk is the most difficult of all foodstuffs to collect, handle, and deliver in a sanitary condition.

Milk harbors bacteria of many varieties and favors their growth and development. Fortunately, most of these bacteria are harmless, or, in other words, may be classed as "desirable".

Milk at times may become infected and convey the germs of disease. For this reason pasteurization of all market milk is recommended.

Cows and milkers should be clean and healthy.

Grooming the cows and feeding dusty hay, silage, or other strong smelling feeds just before milking are to be avoided.

Just previous to milking the udder and flank should be wiped with a damp cloth.

The hands should be clean and dry when milking.

Only sanitary milk pails with small openings should be used.

Only thoroughly cleaned and sterilized utensils should be used.

Milk should be removed from the barn as soon as milked.

Milk should be cooled at once to 50° F., or lower. Clean milk properly cooled and protected shows very little change in 3 or even 5 or 10 days.

BETTER MILK MEANS INCREASED CONSUMPTION AND THEREFORE A GREATER DEMAND.

(College Series No. 242)